# PATENT ABSTRACTS OF JAPAN

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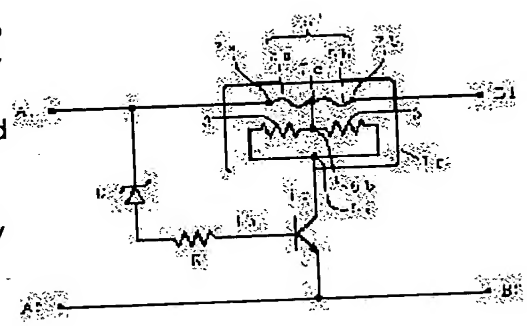
## (54) PROTECTIVE ELEMENT

(57)Abstract:
PROBLEM TO BE SOLVED: To improve reliability in operation as a protective element and stability in production in a protective element, having a heating element and a low- melting point metallic body on a substrate and in which the low-melting point metallic body is melted by generation of heat of the heat generating body to flow in onto electrodes, thereby the low-melting point metallic body to be fused.
SOLUTION: The protective element 1p has a heating element 3 and a low- melting point metallic body 5 on a substrate, and the low-melting point metallic body 5 is melted by generation of heat of the heating element 3 to flow in onto the electrodes 7a, 7b, 7c, thereby the low-melting point metallic body 5 to be fused. Relation (1) is satisfied. Or if a distance of the electrodes themselves adjoining via the low-melting point metallic body 5, of the electrodes 7a, 7b, 7c, in which the melted low-melting point metal body 5 flows, is defined as the distance between the electrodes, relation (2) is satisfied. (1) [sectional area of low-melting point metallic body]/[effective sectional area of fusing electrode]≤0.15 and (2) 2.5≤[distance between electrodes]/[sectional area of low- melting point metallic body]≤30.



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## CLAIMS

[Claim(s)]
[Claim 1] In the protection component which this low-melt point point metal body melts by having a heating element and a low-melt point point metal body on a substrate, and a low-melt point point metal body's fusing by generation of heat of a heating element, and flowing in on an electrode It is the cross section of this low-melt point point metal body in a field perpendicular to the direction of the current which flows a low-melt point point metal body in the cross section of a low-melt point point metal body. About each electrode with which the low-melt point point metal body which considered as the average of the direction of a current, and fused the fusing effective electrode surface product flows in It is a degree type (1) about at least one electrode with which the fused low-melt point point metal body flows in when considering as the surface area of the electrode which the low-melt point point metal body of a melting condition can wet in 1 minute after a low-melt point point metal body fuses completely and starts a flow.
[The cross section of a low-melt point point metal body] / [fusing effective electrode surface product] <=0.15 (1)
The protection component characterized by carrying out ** satisfactory.
[Claim 2] In the protection component which this low-melt point point metal body melts by having a heating element and a low-melt point point metal body on a substrate, and a low-melt point point metal body's fusing by generation of heat of a heating element, and flowing in on an electrode It is the cross section of this low-melt point point metal body in a field perpendicular to the direction of the current which flows a low-melt point point metal body in the cross section of a low-melt point point metal body. When distance of the electrodes which adjoin each other through a low-melt point point metal body among the electrodes with which it considers as the average of the direction of a current, and the fused low-melt point point metal body flows in is made into inter-electrode distance, it is a degree type (2).
2.5 <= [an inter-electrode distance] / [cross section of low-melt point point metal body] <=30 (2)
The protection component characterized by carrying out ** satisfactory.

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## DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] A heating element generates heat at the time of abnormalities, and this invention relates to the protection component which a low-melt point point metal body melts.
[0002]
[Description of the Prior Art] As a protection component which can be used in order to prevent not only an overcurrent but an overvoltage, the protection component which carried out the laminating of a heating element and the low-melt point point metal body on the substrate is known (JP,2790433,B, JP,8-161990,A, etc.). With this type of protection component, energization is made by the heating element at the time of abnormalities, when a heating element generates heat, a low-melt point point metal fuses and the fused low-melt point point metal body melts by wetting the electrode surface in which this low-melt point point metal body is laid.
[0003] Drawing 1 is the circuit diagram of an example of an overvoltage arrester which used such protection component 1p, and drawing 2 is the top view (this drawing (a)) and sectional view (this drawing (b)) of this protection component 1p.
[0004] This protection component 1p has the structure where the laminating of the heating element 3 formed of spreading of resistive paste etc. on a substrate 2, an insulating layer 4, and the low-melt point point metal body 5 which consists of a fuse ingredient was carried out. Among drawing, 6a and 6b are the electrodes for heating elements, among these electrode 6b connects with electrode (bipolar electrode) 7c of the center section of the low-melt point point metal body 5, and the low-melt point point metal body 5 is classified into two parts 5a and 5b across the connection part. 7a and 7b are the electrodes for low melting point metal bodies. Moreover, in order for 8 to consist of solid flux etc. and to prevent scaling of the low-melt point point metal body 5, it is the inside closure section which is closing the low-melt point point metal body 5, and it is the outside closure section which prevents that 9 consists of an ingredient which has high-melting or high softening temperature rather than the low-melt point point metal body 5, and melt flows out out of a protection component at the time of fusing of the low-melt point point metal body 5.
[0005] This protection component 1p In the used overvoltage arrester of drawing 1 , the electrode terminal of apparatus to be protected, such as a lithium ion battery, is connected to terminals A1 and A2, and the electrode terminal of equipments, such as a battery charger used for a terminal B1 and B-2 to an apparatus to be protected, connecting, is connected to them. If according to this overvoltage arrester charge of a lithium ion battery advances and the overvoltage more than breakdown voltage is impressed to zener diode D, base current ib flows rapidly and it is big collector current ic by that cause. It flows to a heating element 3 and a heating element 3 generates heat. This heat transmits to the low-melt point point metal body 5 on a heating element 3, and two parts 5a and 5b of the low-melt point point metal body 5 melt, respectively. Thereby, they are terminals A1 and A2. It is prevented that an overvoltage is impressed and the energization to a heating element 3 is also intercepted by coincidence.
[0006] Although there is also a mode which arranges superficially a low-melt point point metal body and a heating element on a substrate on a heating element, without carrying out the laminating of the low-melt point point metal body, and is connected as a connection mode of the low-melt point point metal body of this type of protection component, and a heating element as indicated by JP,10-116549,A and JP,10-116550,A, the effectiveness that the energization to a heating element is intercepted by fusing and coincidence of a low-melt point point metal body is the same.

[0007] Drawing 3 is the top view (this drawing (a)) and sectional view (this drawing (b), (c)) of protection component 1q where the low-melt point point metal body 5 melts, and the energization to a heating element 3 was intercepted by coincidence like protection component 1p of drawing 1 when a heating element 4 generated heat by energization (refer to Japanese-Patent-Application-No. No. 110163 [ 11 to ] specification). this protection component 1q -- a substrate 2 top -- a low-melt point point metal -- the body and its function -- Electrodes 7a, 7b, and 7c are formed, and the low-melt point point metal body 5 (5a, 5b) is formed so that these electrodes 7a, 7b, and 7c may be started. Moreover, the heating element 3 is formed in the inferior surface of tongue of electrode 7c through the insulating layer 4. Energization heating of the heating element 3 is carried out between Wiring 6x and 6y and electrode 6b for heating elements which were drawn from electrode 6for heating elements a. Electrode 6b for heating elements has connected with electrode 7c for low-melt point point metal bodies. Therefore, electrode 7a, low-melt point point metal body 5a between 7c, electrode 7b, and low-melt point point metal body 5b between 7c melt, respectively, and the energization to an apparatus to be protected is intercepted by generation of heat of a heating element 3, and the energization to a heating element 3 is also intercepted.

[0008]

[Problem(s) to be Solved by the Invention] by the way -- even if the low-melt point point metal body 5 will be in a melting condition with the conventional protection components 1p and 1q mentioned above at the time of generation of heat of a heating element 3 -- a low-melt point point metal -- the body and its function -- when the area of Electrodes 7a, 7b, and 7c was too narrow, the fused low-melt point point electrode object 5 fully flowed to these electrodes, and did not load them, but there was a problem that the low-melt point point metal body 5 did not melt.

[0009] moreover, a low-melt point point metal -- the body and its function -- also when the distance (inter-electrode distance) of the electrodes which adjoin each other through the low-melt point point metal body 5 among Electrodes 7a, 7b, and 7c was too narrow, there was a problem that fusing was not carried out even if a low-melt point point metal body will be in a melting condition at the time of generation of heat of a heating element 3. Even when inter-electrode distance was too large on the contrary, the low-melt point point metal body 5 became thin locally, and resistance was not fixed and the same resistance was shown with the heat at the time of connecting the low-melt point point metal body 5 on a substrate 2, there were problems, like pulse current-proof nature is inferior. When inter-electrode distance became still larger, and connecting the low-melt point point metal body 5 by thermocompression bonding etc. on a substrate, there was also a problem that the low-melt point point metal body 5 melted.

[0010] In the protection component which this low-melt point point metal body melts by this invention's having a heating element and a low-melt point point metal body on a substrate, and a low-melt point point metal body's fusing it by generation of heat of a heating element to such a problem, and flowing in on an electrode It aims at raising the production stability and dependability of a protection component by optimizing the area and inter-electrode distance of an electrode used as the point at which the low-melt point point metal body of a melting condition flows in at the time of generation of heat of a heating element.

[0011]

[Means for Solving the Problem] In the protection component which this low-melt point point metal body melts by this invention's having a heating element and a low-melt point point metal body on a substrate, and a low-melt point point metal body's fusing it by generation of heat of a heating element, and flowing in on an electrode in order to attain the above-mentioned purpose It is the cross section of this low-melt point point metal body in a field perpendicular to the direction of the current which flows a low-melt point point metal body in the cross section of a low-melt point point metal body. About each electrode with which the low-melt point point metal body which considered as the average of the direction of a current, and fused the fusing effective electrode surface product flows in It is a degree type (1) about at least one electrode with which the fused low-melt point point metal body flows in when considering as the surface area of the electrode which the low-melt point point metal body of a melting condition can wet in 1 minute after a low-melt point point metal body fuses completely and starts a flow.

[The cross section of a low-melt point point metal body] / [fusing effective electrode surface product] <=0.15 (1)

The protection component characterized by carrying out ** satisfactory is offered.

[0012] Moreover, this invention has a heating element and a low-melt point point metal body on a substrate, and a low-melt point point metal body fuses it by generation of heat of a heating element, and it is set for the protection component which this low-melt point point metal body melts by flowing in on an electrode. It is the cross section of this low-melt point point metal body in a field perpendicular to the direction of the current which flows a low-melt point point metal body in the cross section of a low-melt point point metal body. When distance of the electrodes which adjoin each other through a low-melt point point metal body among the electrodes with which it considers as the average of the direction of a current, and the fused low-melt point point metal body flows in is made into inter-electrode distance, it is a degree type (2).
2.5 <= [an inter-electrode distance] / [cross section of low-melt point point metal body] <=30 (2)
The protection component characterized by carrying out ** satisfactory is offered.
[0013] Here, although the cross section of this low-melt point point metal body in a field perpendicular to the direction of the current which flows a low-melt point point metal body as mentioned above is said, in the case this cross section is not fixed about the direction of the current which flows a low-melt point point metal body, the value acquired by averaging the cross section about the direction of that current is called cross section of a low-melt point point metal body.
[0014] Although the low-melt point point metal body which changed into the melting condition completely and started a flow says the surface area of the electrode which can be wet in 1 minute after flow initiation, when a fusing effective electrode surface product has two or more electrodes which the low-melt point point metal body of a melting condition can wet, a formula (1) is made to satisfy about the at least one electrode.
[0015] Moreover, as compared with the area which the low-melt point point metal body of a melting condition can wet [ the total surface area of an electrode ] in [ flow initiation ] 1 minute, although a fusing effective electrode surface product is equal to the total surface area of the electrode with which the fused low-melt point point metal body usually flows in, in being large, a part of total surface area of an electrode turns into a fusing effective electrode surface product.
[0016] Since the protection component of this invention is formed so that an above-mentioned formula (1) or an above-mentioned formula (2) may be satisfied, at the time of generation of heat of a heating element, a low-melt point point metal body melts it promptly, and it becomes that whose dependability as a protection component improved. Moreover, it becomes that whose production stability also improved.
[0017]
[Embodiment of the Invention] Hereafter, this invention is explained to a detail, referring to a drawing. In addition, the same sign expresses the same or equivalent component among each drawing.
[0018] It has a heating element and a low-melt point point metal body on a substrate, a low-melt point point metal body fuses by generation of heat of a heating element, it sets for the protection component which this low-melt point point metal body melts by flowing in on an electrode, and the protection component of this invention is [the cross section of a low-melt point point metal body] / [fusing effective electrode surface product] <=0.15. (1)
Whether the cross section of a low-melt point point metal body and the surface area of the electrode with which the fused low-melt point point metal body flows in are suitably set up so that ** satisfactory may be carried out, and a degree type (2)
2.5 <= [an inter-electrode distance] / [cross section of low-melt point point metal body] <=30 (2)
Mutual spacing of an electrode and the cross section of a low-melt point point metal body into which the fused low-melt point point metal body flows are suitably set up so that it may ******. Preferably, mutual spacing of the electrode with which the cross section of a low-melt point point metal body, the surface area of the electrode with which the fused low-melt point point metal body flows in, and the fused low-melt point point metal body flow in is suitably set up so that the both sides of a formula (1) and a formula (2) may be filled.
[0019] In protection component 1p shown in drawing 2 , as the cross section of a low-melt point point metal body, the cross section of the cross section of the direction of y-y of the low-melt point point metal body 5 is more specifically set up so that an above-mentioned formula (1) and a formula (2) may be filled. Moreover, electrode 7for low-melt point point metal bodies a into which the fused low-melt point point metal body 5 will flow as a fusing effective electrode surface product, It sets up so that an above-mentioned formula may be filled about at least one electrode of 7b and 7c, and as an inter-electrode distance, the distance d2 between the distance d1 between electrode 7for low-melt point point metal bodies a and 7c and electrode 7for low-melt

point point metal bodies b, and 7c is set up similarly.
[0020] Moreover, in protection component 1q shown in drawing 3 , as the cross section of the low-melt point point metal body 5, the cross section of the cross section of the direction of y-y of the low-melt point point metal body 5 is set up so that an above-mentioned formula (1) and a formula (2) may be filled. Electrode 7for low-melt point point metal bodies a into which the fused low-melt point point metal body 5 will flow as a fusing effective electrode surface product, The surface area of at least one electrode of 7b and 7c is set up so that an above-mentioned formula may be filled, and as an inter-electrode distance, the distance d2 between the distance d1 between electrode 7for low-melt point point metal bodies a and 7c and electrode 7for low-melt point point metal bodies b, and 7c is set up similarly.
[0021] Since fusing can be certainly produced by this when the low-melt point point metal body 5 fuses, the dependability of operation as a protection component can be raised. Moreover, a low-melt point point metal body being thinly formed locally at the time of manufacture of a protection component, or melting can be lost, and the production stability of a protection component can be raised.
[0022] As long as, as for the protection component of this invention, an above-mentioned formula (1) or an above-mentioned formula (2) is filled, there is especially no limit about each components, such as a low-melt point point metal body, an electrode, a heating element, and a substrate, or arrangement. For example, as a formation ingredient of the low-melt point point metal body 5, the various low-melt point point metal bodies currently conventionally used as a fuse ingredient can be used, for example, the alloy of a publication can be used for Table 1 of the paragraph [0019] of JP,8-161990,A. Moreover, even when the thin film integrated circuit of the configuration of a low-melt point point metal body is also cylindrical, it is good.
[0023] the electrode with which the fused low-melt point point metal body 5 will flow in, for example, the low-melt point point metal in protection component 1p of drawing 2 , -- the body and its function -- Electrodes 7a, 7b, and 7c and the low-melt point point metal in protection component 1q of drawing 3 -- the body and its function -- there is especially no limit also about the component of Electrodes 7a, 7b, and 7c, and the low-melt point point metal body 5 of a melting condition and a wettability good thing can be used preferably. For example, metal simple substances, such as copper, and a front face shall be formed from Ag-Pt, Au, Ag-Pd, etc.
[0024] Moreover, a heating element 3 applies the resistive paste which consists of organic system binders, such as inorganic system binders, such as electrical conducting materials, such as ruthenium oxide and carbon black, and water glass, or thermosetting resin, and can form it by calcinating if needed. Moreover, thin films, such as ruthenium oxide and carbon black, may be formed by printing, plating, vacuum evaporationo, and the spatter, and you may form by pasting of these films, a laminating, etc.
[0025] Although there is especially no limit and plastic film, a glass epoxy group plate, a ceramic substrate, a metal substrate, etc. can be used as a substrate 2, it is desirable to use an inorganic system substrate.
[0026] An insulating layer 4 can use the inorganic system ingredient with which a heating element 3 and the low-melt point point metal body 5 are insulated and which is a layer, for example, uses various organic system resin, such as an epoxy system, acrylic, and a polyester system, or SiO2 as a principal component. Moreover, when forming an insulating layer 4 from organic system resin, thermally conductive inorganic high system powder may be made to contain so that the heat at the time of generation of heat of a heating element 3 may conduct to the low-melt point point metal body 5 efficiently.
[0027] As mentioned above, although the protection component of this invention was explained to the detail, referring to a drawing, this invention can take further various modes. For example, the number of low-melt point point metal bodies and the number of the electrodes with which the fused low-melt point point metal body will flow in may be increased if needed. Moreover, although the insulating layer 4 is formed on the heating element 3 with the illustrated protection components 1p and 1q, this insulating layer 4 may be omitted (Japanese-Patent-Application-No. No. 94385 [ 11 to ] specification). Moreover, a heating element 3 and the low-melt point point metal body 5 may be superficially arranged on a substrate 2 as indicated by JP,10-116549,A and JP,10-116550,A.
[0028] On the low-melt point point metal body 5, the inside closure section which consists of solid flux etc. in order to prevent the scaling can be prepared, and the outside closure section and the cap which prevent that melt flows out out of a component at the time of fusing of the low-melt point point metal body 5 can be prepared in the outside.
[0029]

[Example] Hereafter, this invention is concretely explained based on an example.
[0030] Protection component 1q of examples 1-8, the example 1 of a comparison - 8 drawing 3 was produced as follows. as a substrate 2 -- an alumina substrate (size 3mmx5mm) -- preparing -- this -- a low-melt point point metal -- the body and its function -- in order to form Electrodes 7a and 7b and the electrodes 6a and 6b for heating elements, Ag paste (the Du Pont make, QS174) was printed, and it calcinated for 30 minutes at 870 degrees C. Next, in order to form a heating element 3, ruthenium oxide system resistive paste (the Du Pont make, DP1900) was printed, and it calcinated for 30 minutes at 870 degrees C (10 micrometers in thickness, magnitude 0.1mmx2.0mm). Next, on the heating element 3, the silica system insulation paste (the Du Pont make, AP5346) was printed, it calcinated for 30 minutes at 500 degrees C, and the insulating layer 4 was formed. an insulating-layer 4 top -- a low-melt point point metal -- the body and its function -- the low-melt point point metal above-mentioned [ electrode 7c ] -- the body and its function -- it formed like Electrodes 7a and 7b. The solder paste (Sn:Pb=90:10) was applied on the electrodes 7a and 7b for low-melt point point metal bodies, and 7c, and thermocompression bonding of the solder foil (Sn:Sb=5:95) (width-of-face W1=1mm, die-length L1=4.2mm) was carried out as a low-melt point point metal body 5 on it.
[0031] In this case, by changing the width of face W2, the die length L2, and area of electrode 7c for low-melt point point metal bodies, as shown in Table 1, and changing the thickness D1 of a solder foil, the cross section of the cross section of the direction of y-y of a solder foil was changed, as shown in Table 1.
[0032] In this way, carry out 4W (power value) impression at the heating element 3 of the protection component of each acquired example and the example of a comparison, and the heating element 3 was made to generate heat (4W actuation), and when a solder foil (low-melt point point metal body 5) was melted, the time amount required by solder foil fusing from 4W impression initiation was measured. In this 4W actuation, the thing which melted what was melted within 20 seconds exceeding O.K. and 20 seconds, or the thing which is not melted was set to NG. A result is shown in Table 1.
[0033]
[Table 1]
An electrode A solder foil [Solder foil cross section] Judgment L2 (mm) W2 (mm) Area (mm2) Cross section (mm2) / [an electrode surface product] Example 1 0.3 1.5 0.45 0.02 0.044 O.K. example 2 0.4 1.5 0.60 0.06 0.100 O.K. example 3 0.5 1.5 0.75 0.06 0.080 O.K. example 4 0.7 1.5 1.05 0.15 0.143 O.K. example 5 0.9 1.8 1.62 0.20 0.123 O.K. example 6 1.4 1.8 2.52 0.30 0.119 O.K. example 7 1.4 2.0 2.80 0.30 0.107 -example 8 1.6 2.0 3.20 0.40 0.125 Example of-comparison 1 0.3 1.5 0.450.08 0.178 Example 2 of NG comparison 0.4 1.5 0.600.10 0.167 Example 3 of NG comparison 0.5 1.5 0.75 0.15 0.200 Example 4 of NG comparison 0.7 1.5 1.05 0.18 0.171 Example 5 of NG comparison 0.9 1.8 1.62 0.30 0.185 Example 6 of NG comparison 1.4 1.8 2.52 0.40 0.159 Example 7 of NG comparison 1.4 2.0 2.80 0.500.179 Example 8 of NG comparison 1.6 2.0 3.200.50 0.156 NG [0034] Although [solder foil cross-section]/[an electrode surface product] stabilizes for it and melts the protection component of the examples 1-8 which are 0.15 or less from Table 1 at the time of 4W actuation, it turns out that [solder foil cross-section]/[an electrode surface product] does not melt the protection component of the examples 1-8 of a comparison exceeding 0.15 at the time of 4W actuation, but lacks in the dependability as a protection component.
[0035] According to examples 9-14 and nine to example of comparison 14 example 1, protection component 1q of drawing 3 was manufactured. In this case, as an alumina substrate, size 3mmx5mm-3mmx9mm was used. Width of face W1 of a solder foil was set to 1mm, and made the die length L1 the die length which added 0.5mm to the distance between electrode 7for low-melt point point metal bodies a, and 7b. All of the size of the electrodes 7a, 7b, and 7c for low-melt point point metal bodies were set to L2=1mm and W2=2mm. a low-melt point point metal -- the body and its function -- the inter-electrode distance d1 between electrode 7a and 7c, and a low-melt point point metal -- the body and its function -- the inter-electrode distance d2 between electrode 7b and 7c presupposed that it is the same, and as shown in Table 2, it changed the inter-electrode distance d1 (or d2).
[0036] In this way, visual observation of the protection component of each acquired example and the example of a comparison was carried out, and the case where the thin part from which the cross section turns into 75% or less of the early cross section in a solder foil (low-melt point point metal body 5) locally was observed was set to NG. Furthermore, 4W actuation which 4W (power value) impression is carried out [ actuation ] at a heating element 3, and makes a heating element 3 generate heat about what was not set to NG was performed, and the

time amount required by solder foil fusing from 4W impression initiation was measured. In this 4W actuation, the thing which melted what was melted within 20 seconds exceeding O.K. and 20 seconds, or the thing which is not melted was set to NG. A result is shown in Table 2.

[0037]

[Table 2]

A solder foil Inter-electrode distance [Inter-electrode distance] A judgment The cross section (mm2) (mm) / [the solder foil cross section] (mm-1) Example 9 0.02 0.6 30.0 O.K. example 10 0.04 0.6 15.0 O.K. example 11 0.06 1.0 16.7 The O.K. example 120.15 0.4 2.7 O.K. example 13 0.20 0.6 3.0 O.K. example 14 0.50 1.53.0 Example 9 of O.K. comparison 0.02 1.0 50.0 Example 10 of NG*1 comparison 0.041.5 37.5 Example 11 of NG*2 comparison 0.06 2.033.3 Example 12 of NG*2 comparison 0.15 0.2 1.3 Example 13 of NG*3 comparison 0.200.42.0 Example 14 of NG*3 comparison 0.50 1.0 2.0 NG*4 *1: At the time of solder foil sticking by pressure, a solder foil does not melt, even if the cross section of a fusing *2:solder foil passes for 60 seconds locally after about 75% of thin *3:4W actuation initiation with partial of the initial cross section, but it is fusing [0038] in 40 seconds after *4:4W actuation initiation. Although a solder foil melts certainly also at the time of 4W actuation, without forming a thin part in a solder foil from Table 2 locally [ the protection component of the examples 9-14 which have [inter-electrode distance]/[the solder foil cross section] in the range of 2.5-30 ] at the time of manufacture of a protection component [Inter-electrode distance] It turns out that / [the solder foil cross section] does not melt certainly, but is inferior to the dependability as a protection component in a protection component in less than 2.5 examples 12-14 of a comparison at the time of 4W actuation. Moreover, it turns out that a solder foil melts the protection component of the examples 9-11 of a comparison for which [inter-electrode distance]/[the solder foil cross section] exceeds 30 at the time of manufacture of a protection component, or a local thin part is formed in a solder foil, and it is inferior to productivity stability.

[0039]

[Effect of the Invention] Since the protection component of this invention is formed so that the ratio of the cross section of a low-melt point point metal body and a fusing effective electrode surface product or the ratio of inter-electrode distance and the cross section of a low-melt point point metal body may serve as predetermined range, its dependability of operation improves as a protection component, and its production stability improves.

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[Translation done.]

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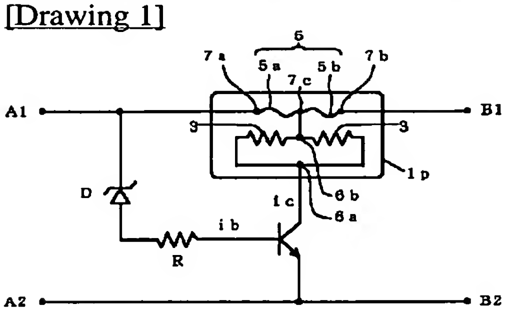
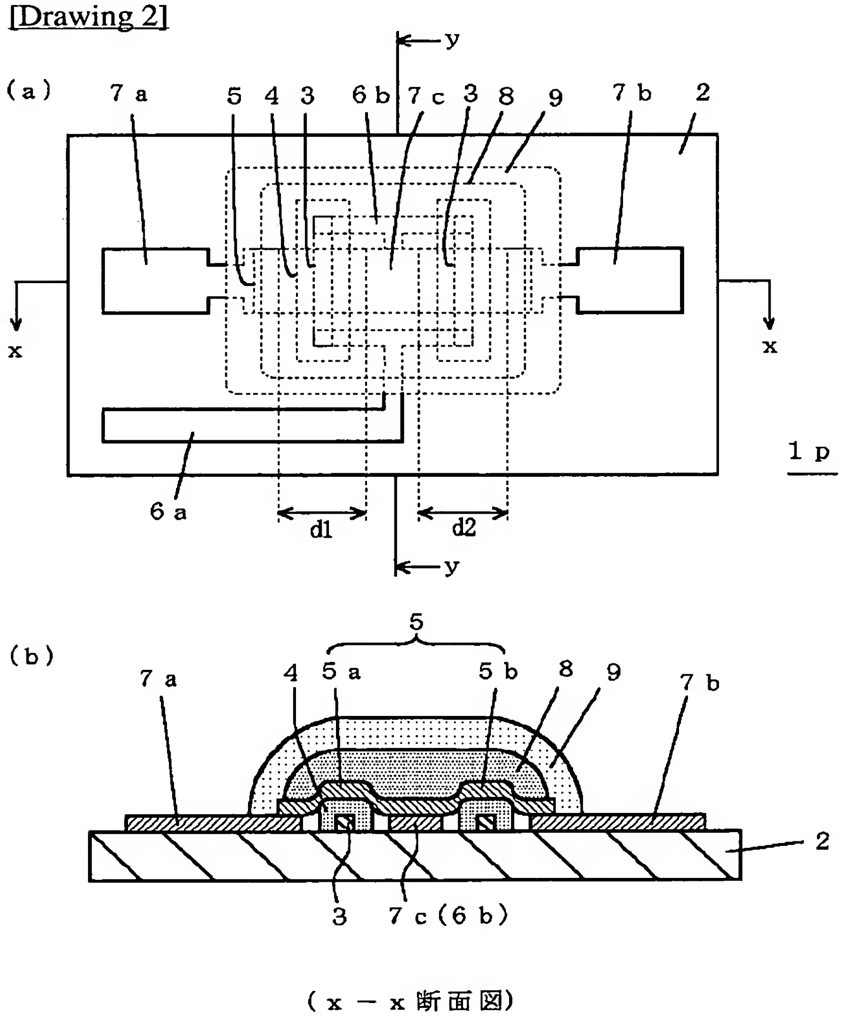
## DRAWINGS

[Drawing 1]

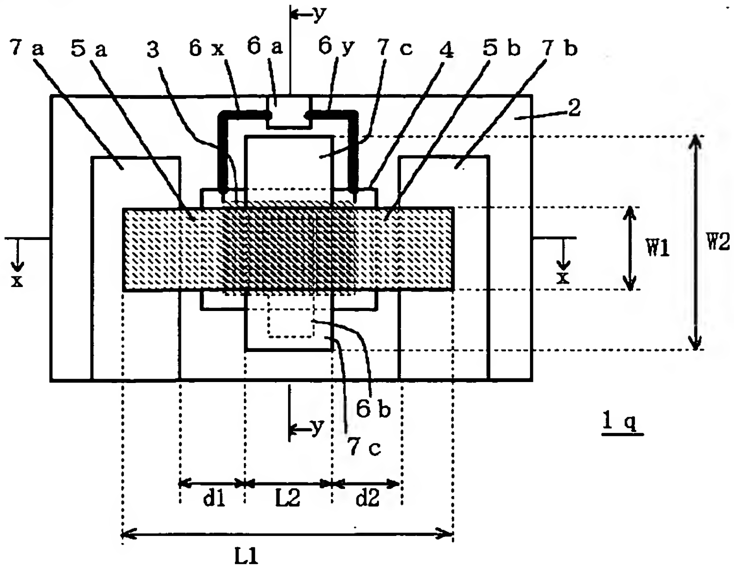



[Drawing 2]

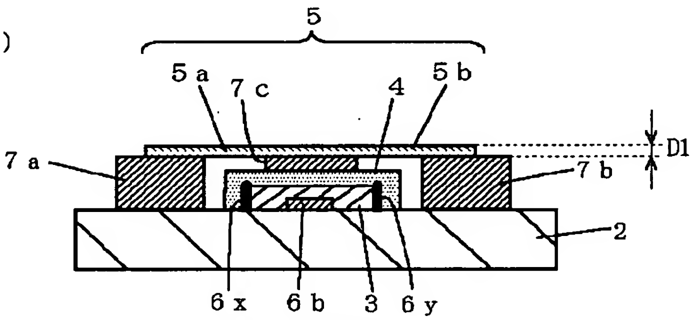


[Drawing 3]

（a）

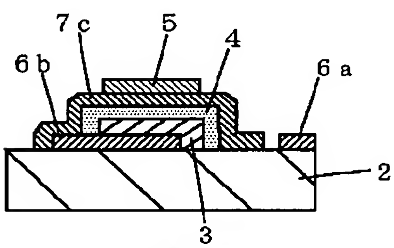



（b）




（x－x断面図）

（b）




（y－y断面図）

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[Translation done.]

# PATENT ABSTRACTS OF JAPAN

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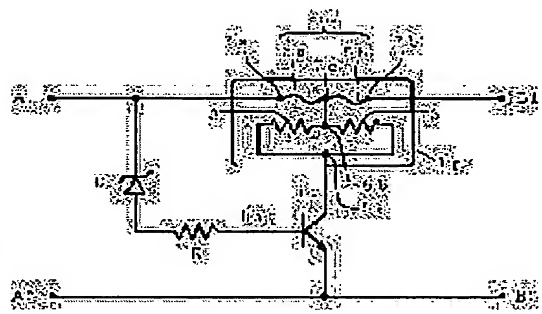
KAWATSU MASAMI

## (54) PROTECTIVE ELEMENT

(57)Abstract:

PROBLEM TO BE SOLVED: To improve reliability in operation as a protective element and stability in production in a protective element, having a heating element and a low- melting point metallic body on a substrate and in which the low-melting point metallic body is melted by generation of heat of the heat generating body to flow in onto electrodes, thereby the low-melting point metallic body to be fused.

SOLUTION: The protective element 1p has a heating element 3 and a low- melting point metallic body 5 on a substrate, and the low-melting point metallic body 5 is melted by generation of heat of the heating element 3 to flow in onto the electrodes 7a, 7b, 7c, thereby the low-melting point metallic body 5 to be fused. Relation (1) is satisfied. Or if a distance of the electrodes themselves adjoining via the low-melting point metallic body 5, of the electrodes 7a, 7b, 7c, in which the melted low-melting point metal body 5 flows, is defined as the distance between the electrodes, relation (2) is satisfied. (1) [sectional area of low-melting point metallic body]/[effective sectional area of fusing electrode] ≤0.15 and (2) 2.5≤[distance between electrodes]/[sectional area of low- melting point metallic body]≤30.



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Ｆターム(参考) 5G502 AA02 BB13 BC01 EE01 EE06

(54)【発明の名称】 保護素子

(57)【要約】

【課題】 基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、保護素子として動作の信頼性と生産安定性を向上させる。

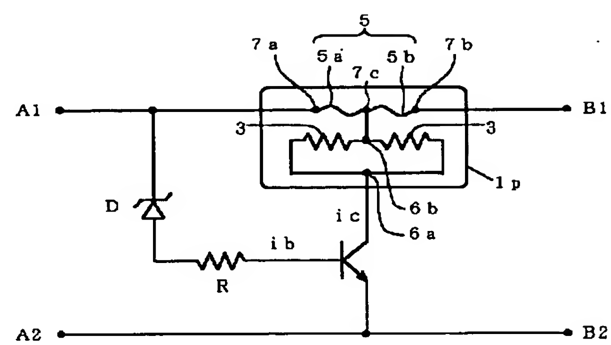
【解決手段】 基板上に発熱体３及び低融点金属体５を有し、発熱体３の発熱により低融点金属体５が溶融し、電極７ａ、７ｂ、７ｃ上に流れ込むことにより該低融点金属体５が溶断する保護素子１ｐにおいて、次式（１）

［低融点金属体の断面積］／［溶断有効電極面積］≦０．１５　（１）

を満足させる。あるいは、溶融した低融点金属体５が流れ込む電極７ａ、７ｂ、７ｃのうち低融点金属体５を介して隣り合う電極同士の距離を電極間距離とした場合に、次式（２）

２．５≦［電極間距離］／［低融点金属体の断面積］≦３０　（２）

を満足させる。



【特許請求の範囲】

【請求項１】　基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、低融点金属体の断面積を、低融点金属体を流れる電流の方向と垂直な面での該低融点金属体の断面積であって、その電流方向の平均値とし、溶断有効電極面積を、溶融した低融点金属体が流れ込む各電極について、低融点金属体が完全に溶融し、流動を開始した後１分間で溶融状態の低融点金属体が濡らし得る電極の表面積とする場合に、溶融した低融点金属体が流れ込む少なくとも一つの電極について、次式（１）

［低融点金属体の断面積］／［溶断有効電極面積］≦０．１５　　（１）

が満足されることを特徴とする保護素子。

【請求項２】　基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、低融点金属体の断面積を、低融点金属体を流れる電流の方向と垂直な面での該低融点金属体の断面積であって、その電流方向の平均値とし、溶融した低融点金属体が流れ込む電極のうち低融点金属体を介して隣り合う電極同士の距離を電極間距離とした場合に、次式（２）

２．５≦［電極間距離］／［低融点金属体の断面積］≦３０　　（２）

が満足されることを特徴とする保護素子。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、異常時に発熱体が発熱し、低融点金属体が溶断する保護素子に関する。

【０００２】

【従来の技術】過電流だけでなく過電圧も防止するために使用できる保護素子として、基板上に発熱体と低融点金属体を積層した保護素子が知られている（特許２７９０４３３号公報、特開平８－１６１９９０号公報等）。このタイプの保護素子では、異常時に、発熱体に通電がなされ、発熱体が発熱することにより低融点金属が溶融し、溶融した低融点金属体が、該低融点金属体が載置されている電極表面を濡らすことにより溶断する。

【０００３】図１は、このような保護素子１ｐを用いた過電圧防止装置の一例の回路図であり、図２は、この保護素子１ｐの平面図（同図（ａ））及び断面図（同図（ｂ））である。

【０００４】この保護素子１ｐは基板２上に、抵抗ペーストの塗布などにより形成される発熱体３、絶縁層４、ヒューズ材料からなる低融点金属体５が積層された構造を有している。図中、６ａ、６ｂは発熱体用電極であり、このうち電極６ｂが低融点金属体５の中央部の電極（中間電極）７ｃと接続し、その接続部位を挟んで低融点金属体５が２つの部位５ａ、５ｂに区分される。７ａ、７ｂは低融点金属体用電極である。また、８は固形フラックス等からなり、低融点金属体５の表面酸化を防止するために低融点金属体５を封止している内側封止部であり、９は低融点金属体５よりも高融点又は高軟化点を有する材料からなり、低融点金属体５の溶断時に溶融物が保護素子外へ流出することを防止する外側封止部である。

【０００５】この保護素子1p を用いた図１の過電圧防止装置において、端子A1、A2には、例えばリチウムイオン電池等の被保護装置の電極端子が接続され、端子B1、B2には、被保護装置に接続して使用される充電器等の装置の電極端子が接続される。この過電圧防止装置によれば、リチウムイオン電池の充電が進行し、ツエナダイオードDに降伏電圧以上の過電圧が印加されると、急激にベース電流ｉbが流れ、それにより大きなコレクタ電流ｉc が発熱体３に流れ、発熱体３が発熱する。この熱が、発熱体３上の低融点金属体５に伝達し、低融点金属体５の２つの部位５ａ、５ｂがそれぞれ溶断する。これにより、端子A1、A2 に過電圧の印加されることが防止され、同時に、発熱体３への通電も遮断される。

【０００６】このタイプの保護素子の低融点金属体と発熱体との接続態様としては、特開平１０－１１６５４９号公報、特開平１０－１１６５５０号公報に記載されているように、発熱体上に低融点金属体を積層せずに、低融点金属体と発熱体とを基板上に平面的に配設して接続する態様もあるが、低融点金属体の溶断と同時に発熱体への通電が遮断されるようにするという効果は同じである。

【０００７】図３は、図１の保護素子１ｐと同様に、発熱体４が通電によって発熱することにより低融点金属体５が溶断し、同時に発熱体３への通電が遮断されるようにした保護素子１ｑの平面図（同図（ａ））及び断面図（同図（ｂ）、（ｃ））である（特願平１１－１１０１６３号明細書参照）。この保護素子１ｑでは、基板２上に低融点金属体用電極７ａ、７ｂ、７ｃが設けられ、これらの電極７ａ、７ｂ、７ｃに架かるように低融点金属体５（５ａ、５ｂ）が設けられている。また、電極７ｃの下面には絶縁層４を介して発熱体３が設けられている。発熱体３は、発熱体用電極６ａから導出された配線６ｘ、６ｙと発熱体用電極６ｂとの間で通電加熱される。発熱体用電極６ｂは、低融点金属体用電極７ｃと接続している。したがって、発熱体３の発熱により、電極７ａ、７ｃ間の低融点金属体５ａと電極７ｂ、７ｃ間の低融点金属体５ｂがそれぞれ溶断して被保護装置への通電が遮断され、また発熱体３への通電も遮断される。

【０００８】

【発明が解決しようとする課題】ところで、上述した従来の保護素子１ｐ、１ｑでは、発熱体３の発熱時に低融点金属体５が溶融状態になっても、低融点金属体用電極

７ａ、７ｂ、７ｃの面積が狭すぎると、溶融した低融点電極体５がこれらの電極に十分に流れ込めず、低融点金属体５が溶断しないという問題があった。

【０００９】また、低融点金属体用電極７ａ、７ｂ、７ｃのうち、低融点金属体５を介して隣り合う電極同士の距離（電極間距離）が狭すぎる場合にも、発熱体３の発熱時に低融点金属体が溶融状態にはなっても溶断はしないという問題があった。反対に電極間距離が広すぎると、基板２上に低融点金属体５を接続する際の熱によって、低融点金属体５が局部的に細くなり、抵抗値が一定せず、また、同じ抵抗値を示す場合でも耐パルス電流性が劣る等の問題があった。電極間距離がさらに広くなった場合には、低融点金属体５を基板上に熱圧着等によって接続する際に低融点金属体５が溶断するという問題もあった。

【００１０】このような問題に対し、本発明は、基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、発熱体の発熱時に溶融状態の低融点金属体が流れ込む先となる電極の面積や電極間距離を最適化することにより、保護素子の生産安定性と信頼性を向上させることを目的とする。

【００１１】

【課題を解決するための手段】上記の目的を達成するため、本発明は、基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、低融点金属体の断面積を、低融点金属体を流れる電流の方向と垂直な面での該低融点金属体の断面積であって、その電流方向の平均値とし、溶断有効電極面積を、溶融した低融点金属体が流れ込む各電極について、低融点金属体が完全に溶融し、流動を開始した後１分間で溶融状態の低融点金属体が濡らし得る電極の表面積とする場合に、溶融した低融点金属体が流れ込む少なくとも一つの電極について、次式（１）

［低融点金属体の断面積］／［溶断有効電極面積］≦０．１５　　　（１）

が満足されることを特徴とする保護素子を提供する。

【００１２】また、本発明は、基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において、低融点金属体の断面積を、低融点金属体を流れる電流の方向と垂直な面での該低融点金属体の断面積であって、その電流方向の平均値とし、溶融した低融点金属体が流れ込む電極のうち低融点金属体を介して隣り合う電極同士の距離を電極間距離とした場合に、次式（２）

２．５≦［電極間距離］／［低融点金属体の断面積］≦３０　　　（２）

が満足されることを特徴とする保護素子を提供する。

【００１３】ここで、低融点金属体の断面積とは、上述のように、低融点金属体を流れる電流の方向と垂直な面での該低融点金属体の断面積をいうが、この断面積が低融点金属体を流れる電流の方向について一定でない場合には、その電流の方向について断面積を平均することにより得られる値をいう。

【００１４】溶断有効電極面積とは、完全に溶融状態となり、流動を開始した低融点金属体が、流動開始後１分間で濡らし得る電極の表面積をいうが、溶融状態の低融点金属体が濡らし得る電極が複数ある場合には、その少なくとも一つの電極について式（１）が満足されるようにする。

【００１５】また、溶断有効電極面積は、通常は、溶融した低融点金属体が流れ込む電極の全表面積に等しいが、電極の全表面積が、溶融状態の低融点金属体が流動開始１分間で濡らし得る面積に比して広い場合には、電極の全表面積の一部が溶断有効電極面積となる。

【００１６】本発明の保護素子は、上述の式（１）又は式（２）を満足するように形成されているので、発熱体の発熱時には、速やかに低融点金属体が溶断し、保護素子としての信頼性が向上したものとなる。また、生産安定性も向上したものとなる。

【００１７】

【発明の実施の形態】以下、図面を参照しつつ本発明を詳細に説明する。なお、各図中、同一符号は、同一又は同等の構成要素を表している。

【００１８】本発明の保護素子は、基板上に発熱体及び低融点金属体を有し、発熱体の発熱により低融点金属体が溶融し、電極上に流れ込むことにより該低融点金属体が溶断する保護素子において

［低融点金属体の断面積］／［溶断有効電極面積］≦０．１５　　　（１）

が満足されるように、低融点金属体の断面積と、溶融した低融点金属体が流れ込む電極の表面積を適宜設定するか、あるいは、次式（２）

２．５≦［電極間距離］／［低融点金属体の断面積］≦３０　　　（２）

が満たされるように、溶融した低融点金属体が流れ込む電極の相互の間隔と低融点金属体の断面積を適宜設定したものである。好ましくは、式（１）及び式（２）の双方が満たされるように、低融点金属体の断面積、溶融した低融点金属体が流れ込む電極の表面積及び溶融した低融点金属体が流れ込む電極の相互の間隔を適宜設定する。

【００１９】より具体的には、例えば図２に示した保護素子１ｐにおいて、低融点金属体の断面積として、低融点金属体５のｙ－ｙ方向の断面の断面積を上述の式

（1）、式（2）が満たされるように設定する。また、溶断有効電極面積としては、溶融した低融点金属体５が流れ込むこととなる低融点金属体用電極７ａ、７ｂ、７ｃの少なくとも一つの電極について上述の式が満たされるように設定し、電極間距離としては、低融点金属体用電極７ａ、７ｃ間の距離ｄ１及び低融点金属体用電極７ｂ、７ｃ間の距離ｄ２を同様に設定する。

【００２０】また、図３に示した保護素子１ｑにおいては、低融点金属体５の断面積として、低融点金属体５のｙ－ｙ方向の断面の断面積を上述の式（１）、式（２）が満たされるように設定する。溶断有効電極面積としては、溶融した低融点金属体５が流れ込むこととなる低融点金属体用電極７ａ、７ｂ、７ｃの少なくとも一つの電極の表面積を上述の式が満たされるように設定し、電極間距離としては、低融点金属体用電極７ａ、７ｃ間の距離ｄ１及び低融点金属体用電極７ｂ、７ｃ間の距離ｄ２を同様に設定する。

【００２１】これにより、低融点金属体５が溶融した場合に確実に溶断を生じさせることができるので、保護素子としての動作の信頼性を向上させることができる。また、保護素子の製造時に低融点金属体が局部的に細く形成されたり、溶断したりすることがなくなり、保護素子の生産安定性を向上させることができる。

【００２２】本発明の保護素子は、上述の式（１）又は式（２）が満たされる限り、低融点金属体、電極、発熱体、基板等の個々の構成材料や配置等については特に制限はない。例えば、低融点金属体５の形成材料としては、従来よりヒューズ材料として使用されている種々の低融点金属体を使用することができ、例えば、特開平８－１６１９９０号公報の段落［００１９］の表１に記載の合金を使用することができる。また、低融点金属体の形状は、薄片状でも棒状でもよい。

【００２３】溶融した低融点金属体５が流れ込むこととなる電極、例えば、図２の保護素子１ｐにおける低融点金属体用電極７ａ、７ｂ、７ｃや、図３の保護素子１ｑにおける低融点金属体用電極７ａ、７ｂ、７ｃの構成材料についても特に制限はなく、溶融状態の低融点金属体５と濡れ性のよいものを好ましく使用することができる。例えば、銅等の金属単体や、表面がＡｇ－Ｐｔ、Ａｕ、Ａｇ－Ｐｄ等から形成されているものとする。

【００２４】また、発熱体３は、例えば、酸化ルテニウム、カーボンブラック等の導電材料と水ガラス等の無機系バインダあるいは熱硬化性樹脂等の有機系バインダからなる抵抗ペーストを塗布し、必要に応じて焼成することにより形成できる。また、酸化ルテニウム、カーボンブラック等の薄膜を印刷、メッキ、蒸着、スパッタで形成してもよく、これらのフィルムの貼付、積層等により形成してもよい。

【００２５】基板２としては、特に制限はなく、プラスチックフィルム、ガラスエポキシ基板、セラミック基板、金属基板等を使用することができるが、無機系基板を使用することが好ましい。

【００２６】絶縁層４は、発熱体３と低融点金属体５とを絶縁する層であり、例えば、エポキシ系、アクリル系、ポリエステル系等の種々の有機系樹脂あるいは$SiO_2$を主成分とする無機系材料を使用することができる。また、絶縁層４を有機系樹脂から形成する場合には、発熱体３の発熱時の熱が効率的に低融点金属体５に伝導するように、熱伝導性の高い無機系粉末を含有させてもよい。

【００２７】以上、図面を参照しつつ本発明の保護素子を詳細に説明したが、本発明はさらに種々の態様をとることができる。例えば、必要に応じて低融点金属体の数や、溶融した低融点金属体が流れ込むこととなる電極の数を増してもよい。また、図示した保護素子１ｐ、１ｑでは発熱体３上に絶縁層４が設けられているが、この絶縁層４は省略してもよい（特願平１１－９４３８５号明細書）。また、特開平１０－１１６５４９号公報、特開平１０－１１６５５０号公報に記載されているように、発熱体３と低融点金属体５とを基板２上で平面的に配置してもよい。

【００２８】低融点金属体５の上には、その表面酸化を防止するために、固形フラックス等からなる内側封止部を設け、その外側には、低融点金属体５の溶断時に溶融物が素子外へ流出することを防止する外側封止部やキャップを設けることができる。

【００２９】

【実施例】以下、本発明を実施例に基づいて具体的に説明する。

【００３０】実施例１～８、比較例１～８

図３の保護素子１ｑを次のように作製した。基板２として、アルミナ基板（サイズ３ｍｍ×５ｍｍ）を用意し、これに、低融点金属体用電極７ａ、７ｂ及び発熱体用電極６ａ、６ｂを形成するため、Ａｇペースト（デュポン社製、ＱＳ１７４）を印刷し、８７０℃で３０分間焼成した。次に、発熱体３を形成するため、酸化ルテニウム系抵抗ペースト（デュポン社製、ＤＰ１９００）を印刷し、８７０℃で３０分間焼成した（厚さ１０μｍ、大きさ０．１ｍｍ×２．０ｍｍ）。次に、発熱体３上にシリカ系絶縁ペースト（デュポン社製、ＡＰ５３４６）を印刷し、５００℃で３０分間焼成して絶縁層４を形成した。絶縁層４上に低融点金属体用電極７ｃを上述の低融点金属体用電極７ａ、７ｂと同様に形成した。低融点金属体用電極７ａ、７ｂ、７ｃ上にソルダーペースト（Ｓｎ：Ｐｂ＝９０：１０）を塗布し、その上に低融点金属体５として、半田箔（Ｓｎ：Ｓｂ＝５：９５）（幅W1＝１ｍｍ、長さL1＝４．２ｍｍ）を熱圧着した。

【００３１】この場合、低融点金属体用電極７ｃの幅W2、長さL2及び面積を表１のように変え、また、半田箔の厚さD1を変えることにより半田箔のｙ－ｙ方向の断面

の断面積を表１のように変えた。

【００３２】こうして得られた各実施例及び比較例の保護素子の発熱体３に４Ｗ（動力値）印加して発熱体３を発熱させ（４Ｗ動作）、半田箔（低融点金属体５）を溶断する場合において、４Ｗ印加開始から半田箔溶断までに要した時間を計測した。この４Ｗ動作において、２０秒以内に溶断したものをＯＫ、２０秒を超えて溶断したもの、あるいは溶断しないものをＮＧとした。結果を表１に示す。

【００３３】

【表１】

| | 電極 L2(mm) | 電極 W2(mm) | 電極 面積(mm2) | 半田箔 断面積(mm2) | [半田箔断面積] ／[電極面積] | 判定 |
|---|---|---|---|---|---|---|
| 実施例１ | 0.3 | 1.5 | 0.45 | 0.02 | 0.044 | ＯＫ |
| 実施例２ | 0.4 | 1.5 | 0.60 | 0.06 | 0.100 | ＯＫ |
| 実施例３ | 0.5 | 1.5 | 0.75 | 0.06 | 0.080 | ＯＫ |
| 実施例４ | 0.7 | 1.5 | 1.05 | 0.15 | 0.143 | ＯＫ |
| 実施例５ | 0.9 | 1.8 | 1.62 | 0.20 | 0.123 | ＯＫ |
| 実施例６ | 1.4 | 1.8 | 2.52 | 0.30 | 0.119 | ＯＫ |
| 実施例７ | 1.4 | 2.0 | 2.80 | 0.30 | 0.107 | ＯＫ |
| 実施例８ | 1.6 | 2.0 | 3.20 | 0.40 | 0.125 | ＯＫ |
| 比較例１ | 0.3 | 1.5 | 0.45 | 0.08 | 0.178 | ＮＧ |
| 比較例２ | 0.4 | 1.5 | 0.60 | 0.10 | 0.167 | ＮＧ |
| 比較例３ | 0.5 | 1.5 | 0.75 | 0.15 | 0.200 | ＮＧ |
| 比較例４ | 0.7 | 1.5 | 1.05 | 0.18 | 0.171 | ＮＧ |
| 比較例５ | 0.9 | 1.8 | 1.62 | 0.30 | 0.185 | ＮＧ |
| 比較例６ | 1.4 | 1.8 | 2.52 | 0.40 | 0.159 | ＮＧ |
| 比較例７ | 1.4 | 2.0 | 2.80 | 0.50 | 0.179 | ＮＧ |
| 比較例８ | 1.6 | 2.0 | 3.20 | 0.50 | 0.156 | ＮＧ |

【００３４】表１から、［半田箔断面積］／［電極面積］が０．１５以下である実施例１〜８の保護素子は４Ｗ動作時に安定して溶断するが、［半田箔断面積］／［電極面積］が０．１５を超える比較例１〜８の保護素子は４Ｗ動作時に溶断せず、保護素子としての信頼性に欠けることがわかる。

【００３５】実施例９〜１４、比較例９〜１４

実施例１に準じて図３の保護素子１ｑを製造した。この場合、アルミナ基板としてはサイズ３ｍｍ×５ｍｍ〜３ｍｍ×９ｍｍを使用した。半田箔の幅W1は１ｍｍとし、その長さL1は低融点金属体用電極７ａ、７ｂ間の距離に０．５ｍｍを加えた長さとした。低融点金属体用電極７ａ、７ｂ、７ｃのサイズは、全て、L2＝１ｍｍ、W2＝２ｍｍとした。低融点金属体用電極７ａ、７ｃ間の電極間距離d1と低融点金属体用電極７ｂ、７ｃ間の電極間距離d2は同じとし、電極間距離d1（又はd2）を表２のように変えた。

【００３６】こうして得られた各実施例及び比較例の保護素子を目視観察し、半田箔（低融点金属体５）に、その断面積が局部的に初期の断面積の７５％以下になる細い部分が観察された場合をＮＧとした。さらに、ＮＧにならなかったものについて、発熱体３に４Ｗ（動力値）印加して発熱体３を発熱させる４Ｗ動作を行い、４Ｗ印加開始から半田箔溶断までに要した時間を計測した。この４Ｗ動作において、２０秒以内に溶断したものをＯＫ、２０秒を超えて溶断したもの、あるいは溶断しないものをＮＧとした。結果を表２に示す。

【００３７】

【表２】

| | 半田箔 断面積(mm2) | 電極間距離 (mm) | [電極間距離] ／[半田箔断面積](mm-1) | 判定 |
|---|---|---|---|---|
| 実施例９ | 0.02 | 0.6 | 30.0 | ＯＫ |
| 実施例10 | 0.04 | 0.6 | 15.0 | ＯＫ |
| 実施例11 | 0.06 | 1.0 | 16.7 | ＯＫ |
| 実施例12 | 0.15 | 0.4 | 2.7 | ＯＫ |
| 実施例13 | 0.20 | 0.6 | 3.0 | ＯＫ |
| 実施例14 | 0.50 | 1.5 | 3.0 | ＯＫ |

| | | | | |
|---|---|---|---|---|
| 比較例9 | 0.02 | 1.0 | 50.0 | NG*1 |
| 比較例10 | 0.04 | 1.5 | 37.5 | NG*2 |
| 比較例11 | 0.06 | 2.0 | 33.3 | NG*2 |
| 比較例12 | 0.15 | 0.2 | 1.3 | NG*3 |
| 比較例13 | 0.20 | 0.4 | 2.0 | NG*3 |
| 比較例14 | 0.50 | 1.0 | 2.0 | NG*4 |

*1:半田箔圧着時に半田箔が溶断
*2:半田箔の断面積が、局部的に初期断面積の７５％程度の細い部分あり
*3:４Ｗ動作開始後６０秒経過しても溶断せず
*4:４Ｗ動作開始後４０秒で溶断

【００３８】表２から、［電極間距離］／［半田箔断面積］が２．５～３０の範囲にある実施例９～１４の保護素子は、保護素子の製造時に半田箔に局部的に細い部分が形成されることもなく、また、４Ｗ動作時にも確実に半田箔が溶断するが、［電極間距離］／［半田箔断面積］が２．５未満の比較例１２～１４では４Ｗ動作時に保護素子が確実に溶断せず、保護素子としての信頼性に劣ることがわかる。また、［電極間距離］／［半田箔断面積］が３０を超える比較例９～１１の保護素子は、保護素子の製造時に半田箔が溶断するか、あるいは半田箔に局部的な細い部分が形成され、生産性安定性に劣ることがわかる。

【００３９】

【発明の効果】本発明の保護素子は、低融点金属体の断面積と溶断有効電極面積との比あるいは、電極間距離と低融点金属体の断面積との比が所定の範囲となるように形成されているので、保護素子として動作の信頼性が向上し、また、生産安定性が向上する。

【図面の簡単な説明】

【図１】　保護素子の平面図（同図（ａ））及び断面図（同図（ｂ））である。

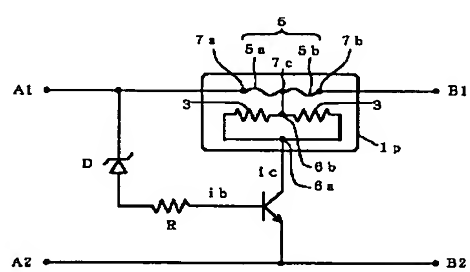
【図２】　保護素子の回路図である。

【図３】　保護素子の平面図（同図（ａ））及び断面図（同図（ｂ）、（ｃ））である。

【符号の説明】

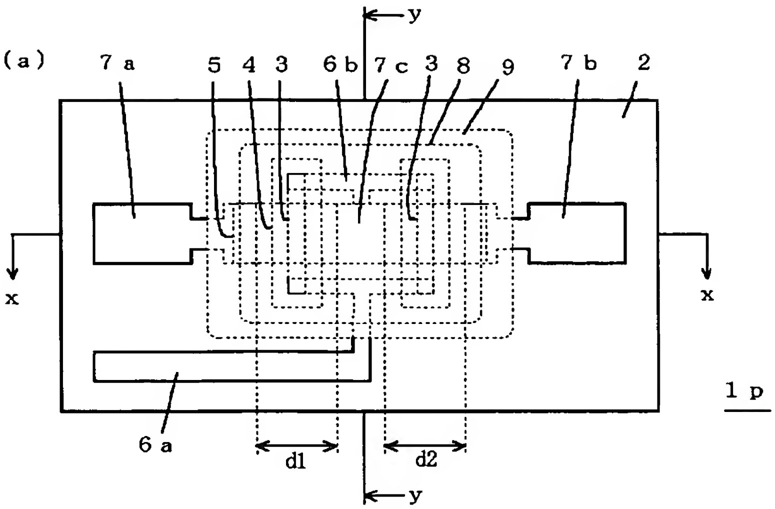
１ｐ、１ｑ…保護素子
２…基板、
３…発熱体、
４…絶縁層、
５…低融点金属体、
６ａ、６ｂ…発熱体用電極、
７ａ、７ｂ、７ｃ…低融点金属体用電極

【図１】

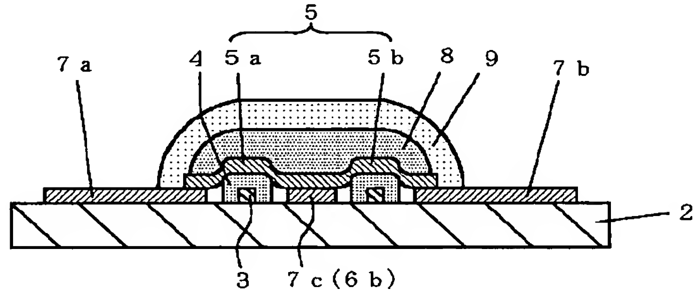


【図2】

(a)



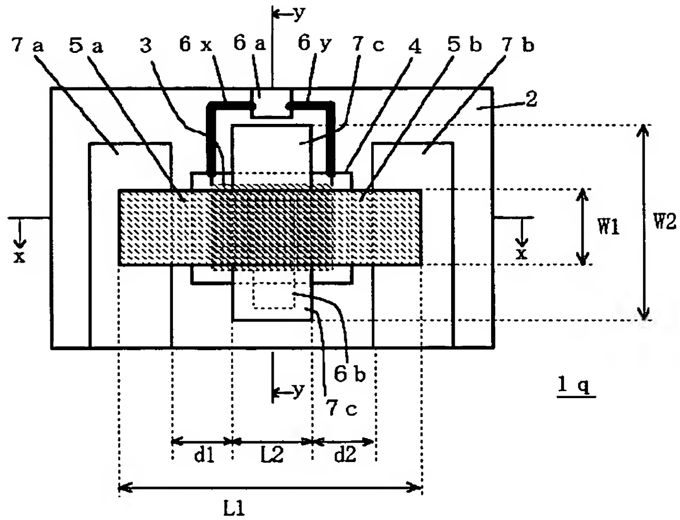

(b)



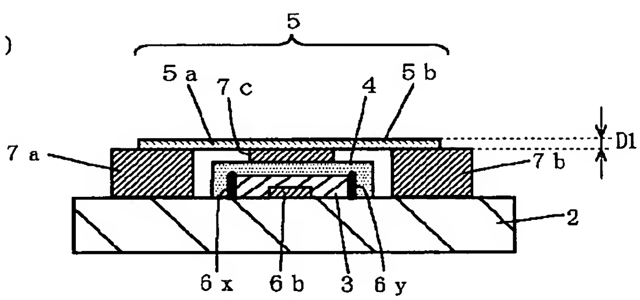

(x − x 断面図)

【図3】

（a）

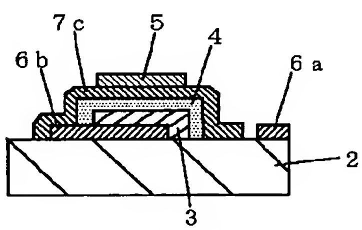



（b）




（x－x断面図）

（b）




（y－y断面図）